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ABSTRACT

This study assessed the theoretical, empirical, and normative evidence addressing the issue of individualized science instruction. The literature on the subject was reviewed and an annotated bibliography prepared with entries grouped into categories asking: (1) Is there a need for individualization in science education? (2) Can individualized instruction be justified by reviewing current research on achievement and attitudes in individualized classrooms? and (3) Is individualized instruction feasible? Following the bibliography (which comprises a major portion of the document) a summary of findings is presented. Among the findings are those which show: that students are different and need different types of science instruction; a need for more individualized approaches; inconclusive results when research on individualized instruction and academic achievement was examined; positive effects of individualized instruction on student attitudes in all but one study; and a need for teacher training as a necessary component in the effective introduction and management of individualized instruction. (JN)

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STUDIES IN INDIVIDUALIZED SCIENCE INSTRUCTION AND ITS EFFECT ON STUDENT ACHIEVEMENT AND ATTITUDES

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by

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INTRODUCTION

During the 1950's and 1960's the developing space program resulted in increased emphasis on science. The launching of Sputnik led to increased financial and public support of the sciences. Large sums of money were spent to produce new materials and update curriculums. This trend began to change during the 1970's and interest in science dwindled (Yager and Penick 1983). Recent statistics show achievement in science on the decline along with enrollments in science classes (Sigda 1983).

These grim statistics have caused science educators to evaluate current science instruction. What has been revealed is a curriculum that is textbook and lecture oriented (Worthy 1982). Students have little input into the science courses that are offered. Most of the emphasis is on the formal study of science or a college preparatory path. Today science education is taught as a body of knowledge with related principles and practices. Students memorize what others have seen and know but are given little chance to experience seeing and knowing for themselves. This type of learning has removed personal interest. It has become regemented, frustrating and meaningless for many students. In a response to this students are losing interest in science and their perceptions of science instruction have become negative (Rossman 1983).

STATEMENT OF THE PROBLEM

Science is an essential part of the curriculum. Students at all levels during their academic career need to be exposed to the processes and products of science (Rossman 1983). Yet teachers and administrators continue to place science instruction low on their lists of priorities. Instruction in grades K-6 averages only 20 minutes a day and only 20% of grade schools have a budget allotment for science supplies (Worthy 1982). Science educators should strive to improve their students' abilities to cope with an increasingly technological world. Educators need to improve science instruction and make it more personal to their students (Sigda 1983). They need to become more student oriented in their techniques. Students need to be provided with instruction in science that is meaningful and of interest to them.

PURPOSE OF THE STUDY

The purpose of this study was to review the literature and assess the theoretical, empirical and normative evidence addressing the issue of individualized science instruction.

ORGANIZATION OF THE STUDY

This study is organized to address three important questions: (1) Is there a need for individualization in science education? (2) Can individualized instruction be

justified by reviewing current research on achievment and attitudes in individualized classrooms? (3) Is individualized instruction feasible?

LIMITATIONS OF THE STUDY

The purpose of the study was to review research in individualization and science instruction. Articles that dealt with individualization in other curricular areas were not used.

The term individualized instruction can be defined in a variety of ways. This study used the definition as given in Good's Dictionary of Education which can be found in the glossary of terms.

GLOSSARY

activity based -- "a method of instruction that stresses the participation of pupils in meaningful learning activities through activity units." (Good 1973:10)

competency based -- "educational system that emphasizes the specification, learning, and demonstration of those competencies that are of central importance to a given task or activity." (Thesaurus of Eric 1984:50)

competition -- "rivalry between individuals or groups seeking the same effect or goal." (Thesaurus of Eric 1984:50)

cooperation -- "group experience, physical, intellectual, or emotional, designed to achieve a common purpose." (Good 1973:10)

education -- "the aggregate of all the processes by means of which a person develops abilities, attitudes and other forms of behavior of positive value in the society in which he lives." (Good 1973:202)

elementary science study (ESS) -- "the purpose of this project is to enrich students' understanding about the world and themselves through the utilization of activities that require readily available materials." (Abruscato and Hassard 1976:14)

environmental inventory -- "measures of learning environment based on pupils' perception of their classroom climate." (Frazer 1978:125)

frontal classroom laboratory (FCL) -- "proceed from one subunit to another using a traditional format of the book." (Lazarowitz and Huppert 1982:111)

individualized audio tutorial (IAT)-- "a multimedia approach to teaching with elements of programmed instruction." (Khan 1980:47)

individualized instruction (II)-- "a type of teaching-learning in which the teacher gives consideration to the individual learner." (Good 1973:305)

individualized science program -- "program that incorporates the idea of students taking on the responsibility for self directed learning." (Campbell 1978:524)

intermediate science curriculum study (ISCS) -- "this project was designed for children from 12 through 15 years of

age. The project materials allow the student to progress through various instructional pathways." (Abruscato and Hassard 1976:14)

learning contract -- "agreement to achieve specified objectives within established time frames with reward dependent upon the level of performance." (Thesaurus of Eric 1984:189)

mastery-based instruction -- "a teaching unit so organized with subject matter and learning activities as to lead to the mastery of a definite major understanding." (Good 1973:632)

naturalistic study -- "obtain data about behavior through direct contact and in terms of specific situations so that distortion is at a minimum." (Kapuscinski 1982: 706)

personalized system of instruction (PSI) -- "adapting instruction to individual needs within the group." (Thesaurus of Eric 1984:125)

practical skills -- "emphasizes preparation for everyday life." (Thesaurus of Eric 1982:185)

process skills -- "emphasizes the learning and demonstration of generalized process skills (observation, classification, measurement, prediction, communication and inference)." (Thesaurus of Eric 1982:188)

science -- "activity carried on as an effort to make the diversity of our sense experiences correspond to a logically uniform system of thought." (Good 1973:516)

science curriculum improvement study (SCIS) -- "an inquiry-oriented course content improvement project that has developed a sequential, articulated elementary school science curriculum based upon the structure of science as seen by scientists." (Krochover and Malcolm 1978:575)

science education -- "education in natural science; education by means of which a person gains in ability to relate his experience with natural events or things in such a manner as to make up, what is for him, a comprehensive and logically uniform system of thought." (Good 1973:517)

self-paced -- "an arrangement whereby provision is made for the individual student to set his own schedule for learning or rate of achievement and to monitor his own progress." (Good 1973:525)

traditional instruction -- "use the mode of lecture, class discussion and teacher demonstrations as prescribed by the science textbook." (Campbell 1978:524)

ANNOTATIONS

IS THERE A NEED?
SCIENCE INSTRUCTION AND THE STUDENT

Baird, J. Hugh, and Others, "Science Choices and Preferences of Middle and Secondary School Students In Utah." Journal of Research In Science Teaching, 1984, 21, 47-54.

The authors administered questionnaires to 1855 students in grades 6-12. This research sought to answer two questions: (1) What subjects do students want to study in science? (2) Are their choices related to age, gender or type of school? The findings showed: (1) The most preferred subjects were zoology, human body and health. (2) Girls preferred life sciences while boys preferred physical sciences. (3) Urban, suburban and rural schools showed little variance in preference of subjects.

Blurton, C., "Individualized Science Packets for Gifted Students." School Science and Mathematics, April 1983, 83, 326-32.

Blurton described the use of science packets in the classroom. Each packet included a synopsis, objectives, pretest and a series of lessons with directions. Blurton used these packets with those students who had already mastered the content of material the rest of the class was studying. He concluded that the packets allowed the teacher to meet the educational needs of these brighter students and avoid boredom, frustration and wasted learning time.

Gabel, D, and Herron, J.D., "Effects of Grouping and Pacing on Learning Rate, Attitude, and Retention in ISCS Classrooms." Journal of Research in Science Teaching, 1977, 14, 385-90.

Gabel and Herron studied 1022 seventh-grade ISCS students in 43 Indiana classrooms. They studied the effects of grouping and pacing on learning rate, retention and attitude. It was concluded that students learned more effectively and showed increased retention when allowed to pace themselves. The results of grouping were inconsistent. All students showed a favorable attitude towards the ISCS program.

Gettinger, Maribeth, "Effects of Learner Ability and Instructional Modification." Journal of Educational Research, J1/Aug 1983, 16, 362-369.

Gettinger researched time needed for learning and retention under various teaching strategies. The author worked with 129 boys in fourth grade. The children were divided into three groups: control, feedback and reduced unit size. The results of this study showed that the students in the feedback and reduced unit size required less time to master the same material than the control group. The groups did not vary in their retention of the presented material. It was concluded that students differed in the amount of time needed to learn a skill to mastery and that the type of instruction they received affected the time needed.

Green, E.L., "Individualized Learning in Science." School Science Review, Sept. 1982, 64, 16-20.

Green stated that inquiry processes are a basic goal of science education. Students learn these processes by actively participating in them. Green discussed the importance of individualized instruction in facilitating student learning. He suggested that teachers needed to combine lecture with individual or group activities. These activities would provide variety, be easily accessible and at an appropriate level and style for students. It is through these techniques that students will be motivated and enthusiastic to continue work in science.

Melton, A.L., "Student Progress in Self-paced, Competency-based Individualized Science Classes in an Alternative Philadelphia School." Education, Summer 1978, 98, 440-3.

Melton studied student progress in alternative high school science classes. He reported results in using a self-paced competency-based individualized progra. Melton was concerned that students were being given diplomas without mastering basic skills. He concluded that the students in the self-paced classes required more time to complete the required work. Only 51% of the students after one year were able to get one year's credit in science. After the second year 88% had completed the work. He concluded that all students require different periods of time to progress through a specific course of study.

Rossman, M., "Why Kids Fail to Learn Science and What to Do About It." Learning, Sept. 1983, 12, 76-80.

Rossman criticized the techniques used by our educational system to teach science. Today science education is taught as a body of knowledge with related principles and practices. Students are expected to memorize these materials and spill them back on a test. Rossman saw this type of learning as impersonal and causing most students to become frustrated and lose interest. Rossman concluded that science should teach students not only what others see and know but how to see and know by themselves. It should emphasize discovery methods and be directed toward student interests.

Sigda, Robert B., "The Crisis In Science Education and the Realities of Science Teaching In the Classroom." Phi Delta Kappan, May 1983, 624-27.

Sigda stated several facts covering the current state of science education. He identified many problems. These included: (1) Since 1960 average achievement tests have shown a steady decline. (2) The average child spends less than one out of 25 instructional hours each week studying science. (3) There has been a steady decrease in enrollments in high school science classes. He concluded with suggestions to improve science instruction: (1) Students should study science every day. (2) Students should be able to study science at their own level. (3) Students should receive a blend of content and process oriented science.

Worthy, Ward, "Improving Science Education for Children." Chemical and Engineering News, Dec. 20, 1982, 60, 39-41.

Worthy reported on a recent workshop he attended sponsored by the American Chemical Society's Committee. The speakers revealed several alarming statistics related to science education. These included: (1) Science instruction in grades K-6 averages 20 minutes a day. (2) On a list of priorities for schools, science is 19th out of 20. (3) Only 20% of K-6 grade schools had budget allotments for science supplies. (4) Most science instruction is taught through textbook and lecture with emphasis on vocabulary.

Yager, R.E., and Penick, J.E., "School Science in Crisis." Curriculum Review, August 1983, 22, 67-70.

Yager and Penick discussed the influx of support science education received during the twenty post-Sputnik years. They contrasted this with the situation of science education in the late 1970's and reviewed three research projects which were designed to determine the status of science education in the U.S. These projects revealed problems which existed in 90% of the sample. Yager and Penick concluded that: (1) 90% of the schools don't offer students the type of science they want. (2) 98% of the science teachers emphasize goals that are oriented towards the formal study of science. (3) 90% of the science teachers use a textbook which dictates the course framework and establishes the students' experiences.

Yager, Robert E., and Penick, John E., "What Students Say About Science Teaching and Science Teachers." Science Education, 1984, 68, 143-152.

Yager and Penick analyzed the results of the 1978 and 1983 assessments in Science by the National Assessment of Educational Progress. These two studies dealt with the affective mode of science instruction. The data came from 9,000 students in two age groups, thirteen years old and seventeen years old. The authors found positive similarities between the two groups: (1) Each valued the study of science and felt it was a useful area of study. (2) Both groups believed their teachers liked science, were enthusiastic and made instruction interesting. In addition each group shared several negative concerns: (1) A lack of input in topics, assignment due dates and testing. (2) Belief that teachers took no personal interest in students. One area where the two groups differed was in the area of individualization. The thirteen year olds felt they were able to work at their own pace, while the seventeen year olds did not.

CAN IT BE JUSTIFIED?
STUDIES IN INDIVIDUALIZED SCIENCE INSTRUCTION
AND ITS EFFECT ON STUDENT ACHIEVEMENT AND ATTITUDES

Anderson, Charles, and Butts, David, "A Comparison of Individualized and Group Instruction in a Sixth-Grade Electricity Unit." Journal of Research in Science Teaching, March 1980, 17, 139-45.

Anderson and Butts used the ESS (Elementary Science Study) unit and compared sixth grade preference for instruction. One class had group instruction and the other class had individualized instruction. The study concluded that there were no differences in either achievement or attitude between the two groups.

Bangert, R.L., and Others, "Individualized Systems of Instruction in Secondary Schools." Education Research, Summer 1983, 53, 143-58.

Bangert, Kulik and Kulik analyzed 51 studies in individualized instruction. The studies covered grades 6-12. It was concluded that in examination performance, positive attitudes, critical thinking skills and self esteem an individualized system had little or insignificant effect. The authors contrasted these findings with results from college level individualized systems. They concluded that elementary and secondary students need more guidance, support and stimulation than an individualized system offers.

Bredderman, T., "What Research Says: Activity Science - The Evidence Shows It Matters." Science and Children, Sept. 1982, 20, 39-41.

Bredderman summarized the results of nearly 60 studies. The studies compared activity-based science with traditional ways of teaching science. Bredderman concluded that activity-based science programs improved student performance in science process, creativity, logic, language development and content. Slight improvement in attitude was also shown. These benefits were most pronounced for disadvantaged students.

Dunkleberger, G.E., and Knight, C.W., "Determination of the Cognitive Consequences Derived from Mastery-based Science Instruction." School Science and Mathematics, My/Je 1981, 81, 383-7.

Dunkleberger and Knight conducted a study with ninth grade science students. The students were divided into two groups. The control group received traditional instruction for laboratory work and the experimental group received mastery-based instruction for laboratory work. Dunkleberger and Knight concluded that the mastery-based students demonstrated greater achievement than the traditionally taught group.

Fraser, B.J., "Measuring Learning Environment in Individualized Junior High School Classrooms." Science Education, Ja/Mr 1978, 62, 125-33.

Fraser administered a revised form of the Environment Inventory to 541 seventh grade students in 20 science classes. Ten of the classes used traditional curriculum materials and the other ten used individualized materials. Fraser observed that students who used the individualized materials perceived their classroom: (1) To have a better environment (availability of resources and materials). (2) More satisfying (students could work in areas of interest). (3) More individualized (students could proceed at their own rates and abilities. Fraser stated that two areas of concern in individualized instruction not perceived by the students were lack of goal direction and disorganization.

Fraser, B.J., and Butts, W.L., "Relationship Between Perceived Levels of Classroom Individualization and Science Related Attitudes." Journal of Research in Science Teaching, 1982, 19, 143-154.

Fraser and Butts conducted a study of the relationship between students' perception of classroom individualization and attitude. The authors analyzed completed questionnaires from 712 students in grades 7-9. The sample included both boys and girls enrolled in science classes in suburban schools. The questionnaires showed: (1) Social implications of science scores were greater in classes perceived as having greater personalization, independence and investigation. (2) Students enjoyed science lessons more in classes perceived as having greater personalization, participation and independence. (3) Leisure and career interest in science was greater in classes perceived as having greater participation. The authors concluded that the more positive attitudes were associated with greater individualization.

Garren, Donald R., and Gathmann, Dennis A., Audio-Tutorial Instruction and Student-Selected Curricula, Educational Resources Information Center, Ed 097890, Lake Land College, Mattoon, Ill., November, 1974, 17 pp.

Garren and Gathmann's study compared achievement test scores in a life science course with students in either an audio-tutorial section or a conventional lecture-laboratory section. The study showed student achievement as measured by tests did not significantly vary. However, the audio-tutorial students were able to complete additional mini-course work during the same time span. Responding to a questionnaire, students indicated a preference for the audio-tutorial learning experience.

Hedges, Larry V., Personalized Introductory Courses: A Longitudinal Study, Oasis Research Report No. 1, Educational Resources Information Center, Ed 120121, California University, San Diego, California, December 1975, 19 pp.

Hedges compared PSI (Personalized System of Instruction) students with conventionally taught students in an introductory physics course. The group of PSI physics students received higher grades in later science courses than the similar group of students who took the lecture course. Hedges concluded that the PSI students received higher grades because they had developed better study skills.

Humphreys, Barbara, and Others, "Effects of Cooperative, Competitive, and Individualistic Learning on Students' Achievement in Science Class." Journal of Research in Science Teaching, May 1982, 19, 351-56.

Humphreys, Johnson and Johnson studied the effects of cooperative, competitive and individualized learning on students' achievement and attitude in science class. Forty-four ninth grade students who had attended three two-week units were evaluated. It was concluded that those students who worked cooperatively did better in both mastery and retention. The same students also had the most positive attitude. The lowest level of interest was in the individualized group.

Khan, Abdul G., "Effects of Audiotutorial and Conventional Instructional Techniques on Cognitive Achievements." Journal of Research in Science Teaching, 1980, 17, 47-53.

Khan conducted a study of 16 students enrolled in a biology class. The students were randomly placed into a control or an experimental group. The control group received a conventional lecture-laboratory form of instruction. The experimental group received instruction by an audiotutorial system. The study showed that the students who received the audiotutorial system had significantly greater cognitive achievement.

Krochover, G.H., and Malcolm, M.D., "Effects of the Science Curriculum Improvement Study Upon a Child's Attitude Toward Science." School Science and Mathematics, Nov. 1978, 78, 575-84.

Krochover and Malcolm conducted research to see if instruction with the SCIS science program would improve a child's attitude toward science. The authors also wanted to determine if the SCIS instruction would change a child's perception of his science experiences. The study involved 307 students in 12 science classes in grades 3-6. The students were heterogeneously grouped into 3 classes per grade level. Within each grade level two classes were selected to be the experimental groups and one the control. The study spanned a four and a half month time period. Krochover and Malcolm concluded that the experimental groups in all grades, except the fourth, showed positive attitude gains, although larger gains were expected. The study also concluded that a child's perception of instruction can change when the type of program is changed.

Lazarowitz, R., and Huppert, J., "Comparison of Grade Distribution Between Jr. High School Biology Students Taught by the Individualized Audio-tutorial and the Frontal Classroom-Laboratory Methods." School Science and Mathematics, 1982, 82, 111-117.

Lazarowitz and Huppert conducted a study with ninth grade science students in an Israeli kibbutzim junior high school. The students were divided into two groups. Both groups used BSCS Yellow Version, "Unity". The experimental group was taught by the individualized audio-tutorial method and the control group was taught by frontal classroom-laboratory method. They concluded that the individualized audio-tutorial method was effective at increasing achievement and motivation. The results showed that 70% of the individualized audio-tutorial students achieved the mastery level while only 30% of the frontal classroom-laboratory group reached the same level.

McMillan, J.H., and May, M.J., "Study of Factors Influencing Attitudes Toward Science of Junior High School Students." Journal of Research in Science Teaching, 1979, 16, 217-22.

McMillan and May interviewed 53 randomly selected junior-high school students. The questions asked pertained to factors influencing their attitudes toward science. They concluded that students are affected most positively by science classes which stress active involvement and experiences, an area controlled by the teacher.

Okebukola, Peter A., and Ogunniyi, Meshach B., "Cooperative, Competitive, and Individualistic Science Laboratory Interaction Patterns - Effects on Students' Achievement and Acquisition of Practical Skills." Journal of Research in Science Teaching, Dec. 1984, 21, 875-884.

Okebukola and Ogunniyi conducted a study to investigate the effects of cooperative, competitive and individualistic science laboratory instruction on student achievement and practical skills acquisition. The sample for the study consisted of 1025 ninth grade students. The students were administered pretests to determine ability levels. They were then placed in five member groups. In the cooperative and competitive conditions there were 3 homogeneous groups, high, average, and low and one heterogeneous group. In the individualistic condition, the high, average, and low categories were for individual students. The authors concluded that the cooperative laboratory instruction significantly improved the cognitive achievement of the students. This was especially positive for the high ability groups and the mixed. The mixed ability groups lead to improved achievement for the low ability students. The competitive instruction lead to greater student achievement of practical skills for all groups.

Repicky, P.A., "Another Individualized Science Program? Yes, but." School Science and Mathematics, Feb. 1978, 78, 93-8.

Repicky analyzed a team of teachers who individualized an existing eighth grade physical science program. The class consisted of 340 students. The method used to individualize was a learning contract. Repicky concluded that noticeable gains were shown on posttests. On the New York State survey test in physical science the median for the group was above the state norm. The teachers were positive about the individualized program and decided to continue it with some modifications. Repicky stated that individualized instruction may not be effective with every student, particularly those who lack self-discipline.

Wise, K.C., and Okey, J.R., "Meta-analysis of the Effects of Various Science Teaching Strategies on Achievement." Journal of Research in Science Teaching, 1983, 20, 419-35.

Wise and Okey conducted a meta-analysis. They synthesized findings of various teaching strategies and their effects on achievement in science. They concluded that an effective science classroom should have the following characteristics: (1) Students are aware of the instructional objectives. (2) Students receive feedback on progress toward these objectives. (3) Students are physically engaged with materials and in activities. (4) Instructional procedures can be changed to increase impact. (5) Verbal and questioning interactions follow a plan. (6) Students are responsible for defining tasks.

IS IT FEASIBLE?
INTRODUCTION AND MANAGEMENT OF
INDIVIDUALIZED SCIENCE INSTRUCTION

Campbell, R.L., "Effects of Teacher Training in the Individualized Science Materials on Achievement of First Grade Students." Science Education, Oct./Dec. 1978, 62, 523-7.

Campbell had two purposes: (1) To investigate the relationship between teacher training in Individualized Science and student cognitive achievement in process skills. (2) The effect of Individualized Science teacher training on teacher attitude and achievement. The study consisted of 135 students placed in an experimental school or a control school. The author concluded: (1) Individualized Science training had a positive effect on teacher attitude and achievement. (2) The students instructed with the Individualized Science program performed significantly better in process skills than those using a traditional textbook approach.

James, Robert K., "A Comparison of Group and Individualized Instructional Techniques in Seventh Grade Science." Journal of Research in Science Teaching, 1972, 9, 91-96.

James studied 60 seventh grade science students. The students were heterogeneously grouped into two classes. One class received group instruction and the other received individualized instruction. The author concluded that: (1) The students' interest in science did not vary between the groups. (2) Achievement did not vary between the two groups. The individualized students were able to assume responsibility for their learning. (3) The classroom was manageable using an individualized instruction model. James was surprised to find that lower ability students did not profit more than other students from the individualized instruction, as was expected.

Jones, Merriam A., "Advantages and Disadvantages of Individualized Instruction." Journal of College Science Teaching, March 1977, 6, 232-33.

Jones surveyed students, teachers and administrators concerning the advantages and disadvantages of individualized instruction. He summarized the major concerns. Some of the advantages listed by students, teachers and administrators were: (1) Course work is self-paced. (2) Students learn the subject better. (3) Teaches students self-discipline. (4) The course is student centered. Disadvantages voiced by students were: (1) Need for self-discipline. (2) More thinking required. Those listed by teachers and administrators: (1) Extra work for teachers. (2) Management problems. (3) Negative attitudes.

Kapuscinski, B.P., "Understanding the Dynamics of Initiating Individualized Science Instruction." Journal of Research in Science Teaching, 1982, 19, 705-716.

Kapuscinski conducted a naturalistic study in the area of individualized instruction in science. The purpose of the study was to identify factors which would influence the introduction of individualized instruction in the classroom. Kapuscinski pointed out a number of areas that would need to be considered. The factors were classified into six groups: teacher, student, course of study, facilities and materials, administration, and the community. A critical area identified was the role of conviction of the teacher and the role of the student in the successful introduction of individualized instruction in science.

McDuffie, Jr., Thomas E., and DeRose, James V., "Five Years of Achievement in ISCS." Science Education, 1982, 66 35-43.

McDuffie and DeRose analyzed 2800 students in 7-9 grade. The students were enrolled in ISCS in a Philadelphia school district. The longitudinal case study took place from 1971-1975. The authors concluded that with time the teachers and students became more effective and efficient in the ISCS program. The teachers were able to increase the quantity of work with no effect on the failure rate. Highly motivated students learned to maximize their use of time. Many highly capable students also performed poorly with the individualized system. These students lacked discipline and organization. The authors stated that for ISCS to work it required the commitment of the school district and the teachers. Most students need much guidance to benefit from the ISCS approach and few students initially will be suited to this type of instruction.

SUMMARY

Several authors, Green, Sigda, Rossman, Worthy and Yager and Penick (1983) have suggested a change in our method of science instruction. They have stated a need for science instruction to become more personal and less textbook oriented. Yager and Penick (1984) who analyzed the results of assessments in science by the National Assessment of Education Progress found that 9,000 thirteen and seventeen year old students valued the study of science. The students also felt it was a useful area of study. One negative finding was that these students felt that they had little input into science course structure, specifically the areas of topics, assignments and due dates. Modifications in present methods of science instruction need to reflect more student involvement. Wise and Okey in their analysis of teaching strategies and effects on achievement concluded that an effective science classroom should have the following characteristics: (1) Students are aware of objectives. (2) Students receive feedback on progress. (3) Students are actively involved in materials. (4) Teachers use a variety of instructional procedures. (5) Students are given some responsibility for defining tasks. (434) These types of modifications helped to increase positive achievement.

Several studies have been conducted examining individuals and different styles of learning. Gettinger studied

instructional modification and its effect on learning. In her study of 129 fourth grade boys she found that students differed in the amount of time needed to learn a skill to mastery and that the type of instruction they received affected this time. Melton found similar results in his study of high school students. Gabel and Herron researched 1022 seventh grade students. They studied the effects of grouping and pacing on learning rate, retention and attitude. The students in the study used the ISCS science materials. These are mastery-based but the time variable could be fixed or flexible. The authors found that the students learned more effectively when they were allowed to pace themselves. These studies by Gettinger, Melton, Gabel and Herron concluded that students have individual differences and students varied in the style that was best for learning. They suggested that we might modify our traditional whole class approach to science instruction and begin to tailor it into a more individual approach.

A review of the research showed some conflicting results between individualized instruction and cognitive achievement. Anderson and Butts compared group and individualized instruction in a sixth grade ESS unit. They found no differences between the two groups in achievement. The same results were reported by Bangert, Kulik and Kulik in their analysis of 51 studies in individualized instruction in grades 6-12. Garren and Gathmann found no difference in achievement between their

conventional and audio-tutorial life science classes. They did find that higher ability students in the audio-tutorial class, because of its self-paced nature, were able to complete more work during the same time span.

None of the studies reported negative cognitive achievement in individualized classrooms and many showed positive cognitive correlations. Dunkleberger and Knight studied mastery-based science instruction and found these students demonstrated greater achievement. Lazarowitz and Huppert, and Khan both researched the effects of audio-tutorial instruction versus a conventional whole group approach and found significantly greater cognitive achievement by the audio-tutorial groups. Lazarowitz and Huppert also found that student motivation increased. Hedges in his study used the personalized system of instruction and a conventional system. He found the PSI increased his students' achievement in later science courses. He concluded that this type of instruction forced his students to develop better study skills. Repicky researched a learning contract method of individualization and found that students showed noticeable achievement gains. He also stated that some students did not profit from this type of instruction, particularly those who lacked self-discipline.

Ogunniyi and Okebukola as well as Humphreys studied grouping and its effect on achievement. The groups formed for each study were the same; cooperative, competitive and

individualistic. Both studies concluded that the cooperatively grouped students showed the most positive achievement gains. Okebukola and Ogunniyi also concluded that cooperative heterogeneous grouping lead to much improved achievement for low ability students.

In the area of various methods of individualization and student attitudes results similar to those found for achievement were concluded. No association was made between an individualized approach and a more negative attitude. All studies showed either no attitude change or a more positive one. Several of the studies which looked at achievement also looked at attitude. These included Anderson and Butts who found no differences in attitude and Bredderman and Garren and Gatherman who found more positive attitudes. Gains in positive attitude were found by Krochover and Malcolm (1978) in their research with the SCIS materials. Fraser (1978) and Fraser and Butts (1982) in their studies of student perceived attitudes stated that the more individualized science classrooms correlated more positive attitudes. Students in these studies found individualized science classes more enjoyable and satisfying because they could work in areas of interest. These students also showed greater interest in science as a career or leisure activity. McMillan and May interviewed 53 students and concluded similar findings. These students were more positively affected by the science classes which stressed active student involvement.

Several authors found that the introduction and management of individualized instruction in the classroom would require teacher training and conviction. Jones, in his survey of teachers concerning individualized instruction, stated several disadvantages voiced by teachers. These included: (1) extra work; (2) management problems; and (3) negative attitudes. These negative attitudes were expressed by many teachers who had never even tried individualization. James, in his study of seventh grade science students, found that individualized instructional techniques were manageable. He stated that if teachers worked at individualized instruction as much as they do group instruction, many problems would be eliminated. Campbell studied the effects of teacher training in individualized science materials and achievement of first grade students. He found that the teacher training had a positive effect on the cognitive achievements of the students and a positive effect on teacher attitudes towards individualization. McDuffie and DeRose found that with time teachers and students both became more effective in the use of individualized materials. They stated that the role of the teacher was very important to the success or failure of individualized science instruction. Kapuscinski also stressed the critical role of conviction of the teacher. He found that teachers who had obtained experience in some type of individualization were more committed to the strategy. He identified other areas that would need to be considered if individualized

instruction was introduced. These included students, course of study, facilities and materilas, administration and community.

CONCLUSION

It was concluded from such authors as Worthy, Rossman, Sigda, and Yager and Penick that student interest and achievement in science is on the decline. The studies by Gettinger, Melton, Gabel and Herron all showed that each student was different and therefore required different types of science instruction. This research established a need for a more individualized approach.

Research in the area of individualized instruction and cognitive achievement in science was more inconclusive. Seven studies, Dunkleberger and Knight, Lazarowitz and Huppert, Khan, Hedges, Repicky, Ogunniyi and Okebukola, and Humphreys all found positive gains in achievement. Three studies, Anderson and Butts, Bangert, Kulik and Kulik, and Garren and Gathmann found no difference in achievement. One could conclude from reviewing their work that individualized instruction was effective with many students but not all.

Individualized instruction techniques had positive effects on student attitudes in all but one of the studies, Anderson and Butts. No negative effects were reported in any of the studies in cognitive achievement or attitude. One could conclude from this research that individualized instruction techniques are justifiable and should be further investigated.

Teacher training was considered a necessary component in the effective introduction and management of individualized instruction. James, Campbell, McDuffie and DeRose all concluded that training and experience in individualized instruction had positive effects on teacher attitudes towards these techniques. These authors alsc concluded that the teacher was one of the main determiners of the success or failure of an individualized approach to science instruction.

RECOMMENDATIONS

It is recommended that:

1. Increased emphasis in the science curriculum on utilizing individualized methods and materials.
2. Continued research into effective methods for teaching science.
3. Increased emphasis in teacher training programs on individualized instruction techniques applied to science.
4. In service or individualized instruction techniques for current teachers.

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